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CIRCULAR NO. 24, SECOND SERIES.

United States Department of Agriculture,

DIVISION OF ENTOMOLOGY.

THE TWO-LINED CHESTNUT BORER.

(*Agrilus bilineatus* Weber.)

RECENT DAMAGE TO FOREST GROWTH.

Recent years have witnessed extensive destruction of forest growth, particularly of pine, spruce, and chestnut, in portions of the United States east of the Rocky Mountains. This injury has been very generally attributed to insects, and there is evidence that certain wood and bark-boring species have largely contributed to the work of demolition. The death of the chestnut trees was laid to the account of the little buprestid borer, *Agrilus bilineatus*, which forms the subject of this circular, and the destruction of the coniferous trees was, in like manner, accredited to the scolytid bark-beetle, *Dendroctonus frontalis* Linn.

A peculiar and interesting feature of what may be called primary insect injury is that it was due very largely to native species not previously known to be injurious. Another singular fact is that the invading forces disappeared as suddenly as they came, and, as is usual in such cases, we are as ignorant of the reason for the insects' disappearance as we are of the inducing cause. As usual also in so many similar instances, these cases of forest-tree injuries were not brought to the attention of entomologists until too late for thorough investigation or experiment.

Since the year 1893 the pine-infesting species has not been reported as injurious, and, in fact, it seems to have entirely disappeared. The opinion has been expressed that its disappearance was due to a fungus disease, and it is possible that such is the case. The chestnut-boring species, however, is still living throughout its accustomed range and in normal abundance.

PROBABILITY OF FUTURE DESTRUCTION OF TREES.

The severe wind storms that swept over the South Atlantic States during the year 1896, particularly that of September 29, which was the severest ever known in this region and caused very extensive destruction of forest and shade trees, will doubtless result in still

greater destruction to trees through the opportunities that the dead, dying, or injured trees afford for the propagation of injurious insects. It should be borne in mind that wood and bark-boring insects generally prefer timber that has been recently killed, and that when this is not available they will attack injured, weakened, or even healthy growth.

It is thus quite possible that we may, within the next year or two, hear of a similar invasion to that experienced a few years ago. As the two-lined chestnut borer, by which name we may know *Agrilus bilineatus*, is a species very likely to cause injury in the immediate future, it has been chosen as the subject of the present circular, and the matter here presented is, in the main, a compilation of facts published in a former article by the writer in Bulletin No. 7, n. s., of this Division.

REPORTED INJURY TO CHESTNUT TREES.

A few of the more important instances of reported injury to chestnut trees may be enumerated herewith. In 1891 an instance was reported from Botetourt County, Va., which, it is more than probable, was due, in part, to the species in question. The following year the two-lined chestnut borer was found to be injurious in the District of Columbia. In 1893 serious injury was reported to the chestnut in Fairfax County, Va., about 75 per cent of the chestnut trees, it was estimated, having been killed by this insect in that and adjoining counties. It was then too late for investigation looking toward remedial experiment, but certain facts were gained concerning the insect and its damage, which will be summarized under another heading. During the same year specimens of the work of this insect in oaks were brought to the writer's attention from Richmond, Ill. Similarly affected trees were noticed at the same time by Mr. G. B. Sudworth, of the Division of Forestry of this Department, in the neighborhood of Ann Arbor, Mich., and other cases of injury were reported by Dr. A. D. Hopkins, entomologist of the West Virginia Agricultural Experiment Station, in and around Madison, Wis.

PREDISPOSING CAUSES OF INJURY.

There has always been a certain degree of skepticism as to whether perfectly healthy forest growth would, save in exceptional cases, succumb to insect attack. There is more often a predisposing agency at work to cause a weakened condition of the trees. Whatever brought this about in the cases reported, there is every appearance that the insect in question multiplied in such numbers that it was forced to attack living, if not healthy, plants or perish, as it belongs to a group that does not develop in timber which has been dead long enough for the bark to become separated from the wood.

Such an enfeebled condition as suggested might be caused by bacterial or fungous disease; or it might be due to a variety of other

factors, among which may be numbered too close growth, defective drainage, insufficiency or a superabundance of subterranean moisture, or too great dryness; or, again, it might be produced by a dry spell suddenly followed by an unusually wet one, or vice versa. In the present case it seems more than probable that the soil had undergone some change that interfered with the growth of the trees, or that a combination of unfavorable atmospheric and soil conditions accomplished the supposed predisposing debility. The withering and dying of leaves induced by a spell of hot, dry weather following cool, moist weather, and known as sun scald, might be provocative of the debilitated condition favorable to the attacks of this borer.

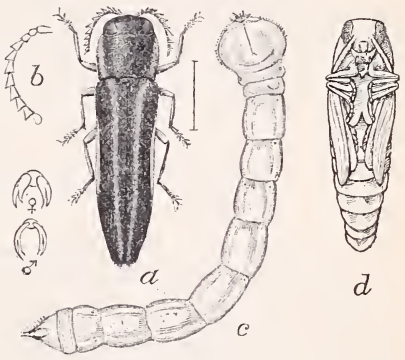

FIG. 1.—*Agrilus bilineatus*: *a*, adult beetle; *b*, antenna of same; ♀, claws of posterior tarsi of female; ♂, same of male; *c*, larva; *d*, pupa—*a*, *b*, *c*, and *d*, enlarged; *b*, ♂, and ♀, more enlarged (author's illustration).

DESCRIPTION OF THE INSECT.

For the identification of the beetle and its larva, the accompanying illustration (fig. 1) is presented. The beetle, shown at *a*, is elongate and subcylindrical, like others of its genus. It is black, with a more or less greenish tinge. The sides of the thorax and elytra are clothed with light golden-yellow pubescence, and the elytra are each marked with a stripe of the same color. It measures about three-eighths of an inch in length, and is fully three times as long as wide. An enlarged antenna is shown at the left (*a*), and below are the claws of the hind feet of both sexes. The larva, drawn to the same scale as the beetle, is illustrated at *c*. It is long, slender, and considerably flattened. In color it is milk white or slightly yellowish, except the mouth-parts and the peculiar anal fork, which are dark brown. Its length is nearly twice that of the adult beetle. The pupa, which is white like the larva, is shown at *d*.

DISTRIBUTION; TIME OF APPEARANCE.

This species is native to the United States, occurring from Maine and Massachusetts southward to Texas and westward to the Rocky Mountains. It will thus be seen that the species occupies what are known as the transition, upper and lower austral life zones; but injuries have been reported only from the upper austral zone, which comprises a considerable portion of the most fertile and most populous parts of our country and that portion in which the chestnut attains its highest development. The districts in which injuries have

been reported are in the District of Columbia and in the States of Virginia, West Virginia, Illinois, Wisconsin, and Michigan; but in all probability the same species has been more or less troublesome in portions of Maryland, Pennsylvania, Indiana, and possibly Ohio, Kentucky, North Carolina, and Tennessee. With such a wide distribution there would be expected a considerable variation in the periods of appearance of the beetle according to climate. In the latitude of the District of Columbia beetles have been captured no earlier than the last week of May, but they undoubtedly appear earlier, and farther south issue from the wood probably at least as early as April. At Ithaca, N. Y., the writer has observed these beetles on oak from May 26 to June 16; at Rosslyn, Va., they were noticed as late as July 4.

NATURE OF DAMAGE AND MANNER OF WORK.

The two-lined chestnut borer works, in its larval stage, just under the bark of the tree, making galleries which run mainly transversely beneath the bark and which are, when completed, from 6 to 10 inches in length. Although none have been observed that completely encircled a tree, the result, through the combined efforts of many individuals, is practically that of girdling.

From the manner of the insect's work it cannot be otherwise than injurious when it occurs in excessive numbers, as it undoubtedly stops the flow of sap, cuts off the natural supply of plant food and moisture, and thus greatly weakens and eventually kills the tree. The larval galleries occur from the base of the tree well up toward the top. It is obvious that only the earlier stage of the larva is passed between the bark and the wood; indeed, it is likely that the entire life of the insect may be passed, in some instances at least, entirely within the bark.

A knowledge of the full life history of the species was not obtained, but it is approximately as follows: In the District of Columbia the adult beetles make their appearance in May and the early part of June, the particular season for their appearance varying according to season and locality, and deposit their eggs upon the trees. The larvæ work under the bark in the manner previously described, and by the following spring construct a chamber which, as far as observed in living trees, is always in the bark; but, in the case of small, dead trees, they work also in the wood under the bark, and in the cells thus formed transform into pupæ. The pupal stage lasts about two weeks or more, according to locality and season, when the beetles again issue from the trees and lay eggs for another brood.

In addition to chestnut this species infests also white oak, scarlet oak (*Quercus coccinea*), and yellow oak (*Q. velutina*).

OTHER BORERS IN CHESTNUT.

As in most cases of insect damage a considerable number of other species of borers and bark-beetles, as well as predaceous and scavenging species, follow the attacks of the primary borer, whether it be the particular species under consideration or some other form. What may be considered as secondary species, judged by the nature of their attack, belong chiefly to the family Cerambycidæ, or long-horned beetles, but there are a few also which belong to the Buprestidæ, Scolytidæ, and Curculionidæ. There are also numerous other families of different orders represented, but it is not within the province of this circular to consider any but the present species, which is the one that has been the cause of the greatest injury in recent years. Many of the secondary forms of borers, although they do not attack or injure living trees, do considerable damage to timber that it is desired to use for building and similar purposes.

PARASITIC ENEMIES.

The two-lined chestnut borer undoubtedly has many insect enemies, as several genera of parasitic Hymenoptera are known to attack other species of its genus. Of the parasitic species observed in this vicinity *Spathius simillimus* Ashm. was the most abundant, and is an undoubted parasite of this borer, as the circumstances of its capture in the galleries of the boring larvæ indicate. It was exceedingly abundant in the vicinity of the District of Columbia during the latter years of the chestnut infestation, and probably played an important role in reducing the numbers of its host. One other parasite has been reared with this species, but it has not been identified at the present writing.

PREVENTIVE AND REMEDIAL MEASURES.

In the absence of a more complete knowledge of the life history and habits of this species, and of an opportunity to test the efficacy of preventive and remedial measures against it, a somewhat general consideration of deterrents and remedies will be given. What is of value against the present species will apply, in the main, to many other true borers.

After the borers once obtain possession of a tree it is next to impossible to save it. Some few species of trees are able to withstand borer attacks for years, while others succumb, unless remedies are applied, in a year or two after the attack begins.

Large forms of boring insects, such as the round-headed apple-tree borer and other species of Saperda, may be cut out of the wood with a knife or may be killed by the insertion of a pliable wire into

the openings of their galleries in the bark. But this is laborious and impracticable against small borers like Agrilus.

Our chief reliance is in preventives, in the employment of mechanical precautionary measures that will serve the double purpose of effectually deterring wood- and bark-boring insects from boring into or depositing their eggs on the trees and from effecting their egress through the bark once they have begun their attack, and in other mechanical measures.

The most important requisite is clean culture; in fact, little of substantial value can be accomplished remedially without it. Owners of forest land who have sufficient financial interests at stake will do well to cut down the dead and to trim the injured trees. For the protection of chestnuts all dead oak as well as chestnut trees, and such as are infested and too feeble to recuperate should be cleared away and burned. Much can be accomplished by simply removing the bark of the dead timber.

Unfortunately, in too many cases storm-killed and injured trees are carelessly permitted to remain as a nidus for borers, and when this wood becomes too dry and the bark too loose for the insects, those that have bred in them emerge and migrate to neighboring living trees.

A frequent and potent source of injury is in the almost universal custom of permitting cut or sawed timber to season without removing the bark, a custom followed alike by the forest landholder, the general farmer, and the mill owner. Even the family woodpile may become a center of infestation. Wood that is cut during winter becomes infested the following spring and early summer, and when left to season through the summer and autumn months should be consumed or otherwise disposed of before the following April. A few cords of wood may develop enough boring insects in a single season to infest and injure acres of woodland. Another source of infestation is in carelessness in permitting dead trees to come in contact with living trees and in bruising or otherwise injuring healthy growth.

The progeny of insects that deposit their eggs in one season so loosen the bark that it may easily be removed and burned before the following spring, thus destroying millions of the insects before they have an opportunity to issue and lay their eggs for the destruction of valuable trees.

In Europe it is customary for foresters to girdle a few trees here and there and leave them standing as traps for such beetles as may not have been destroyed with their host trees. These trees in turn are decorticated the following year and others treated in like manner should appearances indicate the advisability of this course.

Another remedy, rarely if ever used on a large scale and one that does not find favor except for the protection of very valuable shade or fruit trees, consists in a mixture of clay and cow manure spread thickly over the trunk and larger branches; and this may be held in place with newspapers wrapped about the trunks and larger branches. Newspapers alone or tarred paper also give protection. These and similar measures effectually deter boring species from issuing from the trees or laying their eggs upon them. The covering may be removed as soon as the danger has passed, toward the end of July in most cases, this date varying somewhat with the locality and the species of borers which it is desired to guard against. Lighter applications of other mixtures serve the same purpose.

A wash of lime, to which a small quantity of Paris green or other arsenical mixture and a sufficient amount of glue to make it adhesive have been added, is a valuable deterrent, as are also a wash consisting of soft soap reduced to the consistency of thick paint by the addition of a solution of washing soda in water, and a thick wash of soap, plaster of Paris, and Paris green. These washes are best colored like the bark of the tree and this may be accomplished by the addition of a little lamp or bone black. Fish oil is also a valuable deterrent.

In recent years a German product, manufactured from crude petroleum and know as "raupenleim", insect lime, or caterpillar lime, has come into use as a protective remedy against injurious forest-tree insects, and has been the subject of experiment against certain borers affecting fruit trees. This preparation is of nearly the same color and consistency as oil blacking, and has a greasy, tarry odor.

A very similar American product has been lately placed on the market under the name of "dendrolene", and has proved of value against fruit borers that work in a somewhat similar manner to the species in question.

These insect limes must be used with considerable caution, particularly when applied to young trees; since if applied too thickly they are apt to retard the growth and kill the trees. They may be applied with a trowel or paddle and distributed with a stiff brush. The preparation is viscid in character, and, being a mineral product, does not become rancid. A thin application sufficient to retard the beetles from ovipositing on the trunks will last about six weeks; a thicker quantity, or enough to prevent the newly bred insects from emerging through the bark, will endure a much longer time.

Raupenleim may be obtained of the importers in New York City at wholesale in 25 to 250 pound kegs or barrels at the rate of 10 to 15 cents a pound, and dendrolene may be purchased of the manufacturers in New Brunswick, N. J., at about 6 cents.

Whatever is used should be applied for most species just before the first warm spell of spring. At the very outset of an attack a very thin application of kerosene, kerosene emulsion, or creosote by lightly brushing or spraying it over the infested parts, would kill the beetles with which it came in contact.

Protective measures against the two-lined chestnut borer should begin about the first of May in the latitude of the District of Columbia and a little later in more northern and colder localities.

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Approved:
JAMES WILSON,
Secretary.

WASHINGTON, D. C., *July 14, 1897.*